

**ABSTRACT OF THE DISCLOSURE**

A multi layered high impedance structure presents a high impedance to multiple frequency signals, with a different frequency for each layer. Each layer comprises a dielectric substrate, and an array of radiating elements such as parallel conductive strips or conductive patches on the substrate's top surface, with a conductive layer on the bottom surface of the bottommost layer. The radiating elements of succeeding layers are vertically aligned with conductive vias extending through the substrates to connect the radiating elements to the ground plane. Each layer presents as a series of parallel resonant L-C circuits to an E field at a particular signal frequency, resulting in a high impedance surface at that frequency. The new structure can be used as the substrate for a microstrip patch antenna to provide an optimal electrical distance between the resonator and backplane at multiple frequencies. It can also be used in waveguides that transmit multiple signal frequencies signals in one polarization or that are cross-polarized. As a waveguide it maintains a near-uniform density E and H fields, resulting in near uniform signal power density across the waveguide's cross-section.